

## ELECTROLYTIC HEAT SOURCE

The present invention relates to heat sources and in particular to electrolytic heat sources.

### BACKGROUND OF INVENTION

It is generally believed in the scientific community that energy extracted from a system cannot exceed the energy added to the system without decreasing the potential energy of the system. It is also well established that mass is equivalent to energy and can be converted to energy. Considerable worldwide experience shows that in some experiments heat generated by the electrolytic process in a system can be greater than electric power applied to the system in order to produce the electrolytic action. In other words, electrolytic processes can produce a net gain in energy from a system (i.e. excess power), but no generally accepted explanation has been provided for this net gain.

Previous success has been based on creating the unique conditions required for power amplification (i.e. excess power) by chance during extended electrolysis. In a few cases, heat-producing deposits have been applied, *in situ*, within the heat producing electrolytic cell. Szpak et al. (Fusion Technol., 1999 36: p.234) formed the deposits by dissolving  $\text{PdCl}_2$  in a heavy-water electrolytic solution and allowed palladium to deposit on a copper cathode while extra heat was being observed. Miles successfully replicated extra heat using this method. Miley used this method using a sacrificial palladium anode to supply additional palladium to the process.

Several studies have suggested that the excess power can be generated within particles located on the surface of working electrodes where the particles had sizes in the range of nanometers. The preferred size and chemical composition of these particles for most efficient heat-production has not been determined.

What is needed is a technique for providing a net gain in heat energy (i. e. excess power) in an electrolytic system.

## SUMMARY OF THE INVENTION

The present invention provides an electrolytic cell with electrodes on which special materials are deposited to produce heat energy in excess of the electrical energy supplied to an electrolytic cell. Special heat-producing deposits taught by this Invention are deposited on a cathode before it is placed in a heat-producing electrolytic cell. In preferred embodiments, palladium and/or gold particles are deposited on the surface of a platinum cathode. These specially prepared cathodes produce excess power (in the form of heat) when electrolyzed within a working electrolytic cell containing heavy water (Deuterium Oxide) in which LiOD is dissolved. This specification describes how such energy amplification conditions can be created at will, with complete reproducibility. This process results in excess power very soon after electric power is applied to an electrolytic device of the Invention as compared to prior art experiments in which excess power in the form of heat is detected only after a long period of electrolysis.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a preferred embodiment of the present invention.

FIG. 2 is a graph showing the performance of a Seebeck calorimeter.

FIG. 3 shows an example of a Seebeck calorimeter used to accurately measure small energy increments provided by laser light.

FIG. 4 is a graph showing the production of excess power in an electrolytic cell in accordance with the present invention.

FIG. 5 is another graph showing additional performance data demonstrating production of excess energy.

FIG. 6 is a graph showing effects on excess energy of varying the current applied to a electrolytic cell.

FIG. 7 is an exploded view of a preferred embodiment of the present invention.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A demonstration of power amplification process was achieved using a device described in FIG. 1. This cell, made from Pyrex glass, is designed to demonstrate the existence of the power amplification process and to explore a few parameters that influence the

process. The design is not optimized for any practical application of the excess power.

The principal components of this cell are:

- 100 – Platinum cathode plate on which an active surface is deposited ( 5 mm x 9 mm x 0.1mm)
- 101 – Palladium anode wire surrounding the cathode at a uniform distance of 5 mm.
- 102 – Teflon clamp to attach the cathode to the external platinum wire.
- 103 – Glass to metal seal between Pyrex and platinum.
- 104 – Level of liquid electrolyte made from  $D_2O + 0.3\text{ N LiOD}$ .
- 105 – Body of Pyrex container having the shape of a cylinder.
- 106 – Teflon sheet used to isolate the catalyst 107 from the electrolyte.
- 107 – Catalyst used to recombine the  $D_2$  and  $O_2$  back to  $D_2O$ .
- 108 – Rubber o-ring used to seal the cell.
- 109 – Teflon lid through which the glass tubes containing the wires pass.
- 110 – Wire for attaching the anode to a power supply.
- 111 – Wire for attaching the cathode to the power supply.
- 112 – Wire attaching gold sheet to power supply.
- 113 – Wires attaching the internal resistor used for calibration to the power supply.
- 114 – Screws used to compress o-ring seals that seal tubes containing the external wires.
- 115 - Gold sheet used to plate gold on the cathode.
- 116 – Oil filled Pyrex container in which the calibration resistor is located.

#### Cathode Preparation

For this heat amplification process to occur, a thin layer of a special material is applied to the cathode surface. For this embodiment, this layer was applied to clean platinum by electroplating material from a solution. The platinum sheet (1.7 mm x 6.2 mm x 0.1 mm, 99.95% Pt or greater) was cleaned by placing it in Aqua Regia for about 2 minutes, washing with distilled water, and heating to redness using a LP gas plus oxygen flame. An electroplating solution consisted of 50 ml of distilled  $H_2O$  in which was dissolved 2 g  $CaCl_2$ , 0.05 g  $PdCl_2$  and 0.05 g  $AuCN$ . (The purity of these chemicals should be equal to or greater than standard Reagent Grade.) The use of  $CaCl_2$  was chosen based on calcium having a low work function. Plating was continued for 40 min at 0.1 Amp. and  $22^\circ C$ . At the end of this time, the platinum sheet had increased in weight by  $0.00215\text{ g/cm}^2$  and had acquired a uniform black coating. When viewed under an optical microscope at 1000x, the coating was observed to consist of small isolated domains of material having a range of sizes below  $1\text{ }\mu\text{m}$ . The presence of a collection of domains having dimensions less than  $1\text{ }\mu\text{m}$  is thought to be important for power amplification to occur. After being studied as described below in a Seebeck calorimeter, this sample (Pt#3, FIG. 5) was

removed and additional deposit was applied by plating for 54 min at 50 mA using the same solution as used for Pt#3. This sample is identified as Pt#4 during its study in the Seebeck calorimeter. While the sample was within the cell located within the Seebeck calorimeter, gold was added to the surface by passing current into the cell through a gold sheet (115, FIG. 1) immersed in the D<sub>2</sub>O electrolyte (0.3 N LiOD in greater than 99.8% D in D<sub>2</sub>O) that was used as an anode instead of the palladium wire. A current of 0.1 A was applied for 5 h and 45 min. The sample, now designated as Pt#5, was again studied in the Seebeck calorimeter while again using the palladium wire as the anode.

An excess power-producing surface was also applied to a sheet of copper, which generated excess power when studied in a manner as described below.

#### Excess Power Measurement

A demonstration of the claimed power amplification requires that devices used to measure applied power and the resulting heating power are accurate and capable of measuring the required physical quantities. For this purpose a Seebeck calorimeter (Thermonetics Corp., 7834 Esterel Drive, La Jolla, CA 92037) was used because of its known high accuracy and stability.

A Seebeck calorimeter measures the heating power by sensing the temperature of the wall at all positions throughout the interior using thousands of thermocouples located within the walls. The thermocouples are all connected in series and the sensed temperature is the average over the entire inside surface. As long as the temperature of the outside surface of the wall is constant, the amount of heat conducted through the wall is proportional the temperature of the interior, hence to the total voltage generated by the thermocouples. Fans are provided to insure that heat energy is distributed uniformly over the interior surfaces, to minimize effects caused by nonuniformity of the walls to heat loss. By keeping the entire calorimeter at a constant temperature within an enclosure, unexpected changes in heat loss are eliminated.

For this embodiment, the Seebeck calorimeter had the following characteristics:

1. 7"x7"x7" inside dimensions
2. Walls are water cooled by a constant-temperature bath (Neslab RTE-100) held near 20° with a variation of  $\pm 0.02^{\circ}\text{C}$ .
3. The entire Seebeck calorimeter is contained in a box, the inside temperature of the box is held near 20° with a variation of  $\pm 0.01^{\circ}\text{C}$ .
4. Three fans (Radio Shack, 12V, 10 CFM) circulate heat generated by the heat source within the 7"x7"x7" enclosure.
5. The calorimeter is calibrated using a heat source based on electric heating of a resistance wire located within the cell (116, Fig 1). This calibration was undertaken before and after amplified power was determined.
6. Numerous calibrations and studies of cathodes that did not produce power amplification show that the calorimeter is stable to  $\pm 30$  mW over a period of many days and sensitive to within  $\pm 10$  mW to changes in heating power generated within the enclosure over a period of several hours. An example of a typical calibration using the internal resistor and its comparison to electrolytic action in the absence of amplified power is shown in FIG. 2.

Further evidence for the ability of the calorimeter to measure excess power is provided by shining a laser (Optima, 680 nm laser) known to produce 35 mW of light power into the Seebeck calorimeter and measuring the resulting heating power. A typical result of this test is shown in FIG. 3.

All voltages are measured using a National Instruments data acquisition system (PCI-6035E) and a Macintosh computer (Power Mac 7300) running LabView.. Voltage applied to the device within the calorimeter is measured at the thermal wall of the calorimeter. Current is determined by measuring the voltage drop across a resistor in series with the voltage source. Applied power is the product of voltage and current. The same resistor and data acquisition channels are used to measure current and voltage during calibration and during electrolysis. All values are calibrated against a DVM (BK

Precision 5470) accurate to  $\pm 0.0001\text{V}$ . The uncertainty in total applied power used by the fans and by the cell is less than 1 mW.

Excess power (EP) is calculated by applying the following equation:

$$\text{EP} = A + B \cdot V + C \cdot V^2 - \text{AP},$$

where A, B and C are calibration constants obtained by using the internal resistor; V is the voltage generated by the Seebeck calorimeter; and AP is the electric power entering the Seebeck calorimeter.

#### Example of Excess Power Production

When current was applied to a treated platinum cathode using the Seebeck calorimeter, the behavior shown in FIG. 4 was observed immediately after 0.5 A of electrolytic current was applied to the cell. Rather than the long delay in producing excess power, as reported by many other studies, prompt power amplification was observed and the amount slowly increased with time until a constant amount of excess power was being produced. FIG. 5 shows the effect of applied current/cm<sup>2</sup> on excess power/cm<sup>2</sup> after various changes were made in the amount of material on the surface of the platinum cathode designated Pt#3, Pt#4 and Pt#5 after each change in the amount of material applied to the surface. The data obtained using Pt#5 are plotted as EP/AP vs. applied current in FIG. 6. Also plotted is the amount of applied power vs. applied current. Although the amount of power amplification is small, the amount is much larger than the uncertainty in the measurement method. Also, the EP/AP ratio is not optimized in the configuration used for this study. It is important to realize that this excess power results from material present on the working cathode surface in amounts as small as 0.004 g/cm<sup>2</sup>.

#### OTHER EMBODIMENTS

Other methods to deposit active excess heat-producing sites on the surfaces of cathodes can be suggested. An especially effective method involves deposit of a regular array of sites at intervals of a few nanometers to a few microns using a focused beam of ions. A mask containing an array of holes can also be used, through which atoms are vaporized or sputtered onto the cathode surface. Lithographic techniques used to produce integrated

circuits can also be applied to create an ordered array of active sites. Compared to electroplating, these alternative deposition methods offer greater control of size, chemical composition, and density of packing of excess heat-producing active sites on the cathode surface.

Once suitable deposits of excess heat-producing active sites are formed, they require application of sufficient current density to provide sufficient chemical activity of deuterium or hydrogen at the surface of the cathode. In general, the higher the current density, the more heat is produced. A high current density creates two unwanted effects. First, bubbles of  $H_2$  or  $D_2$  and  $O_2$  are produced that must be removed from between the electrodes and recombined back to water. Second, Joule heating of the electrolyte generates conventional heat, which causes inefficiency of the method. The first problem is solved in one of three ways or a combination thereof. First, sufficient gas pressure can be maintained to cause recombination of the  $H_2$  or  $D_2$  and  $O_2$  gases on the cathode and anode surfaces. Second, the liquid can be pumped out of the region between the electrodes at a rate sufficient to reduce the effect of bubble formation. Third, a pulsed current can be applied having a time between pulses sufficient to allow the  $H_2$  or  $D_2$  and  $O_2$  gases to recombine on the electrode surfaces. The second problem can be solved in two ways. First, a small separation can be maintained between the cathode and anode electrodes, consistent with the ability to remove bubbles. Second, a pulsed current can be applied to the cell such that the high instantaneous current is sufficient to provide a high chemical activity while the time during which current is turned off or reduced is brief enough to prevent too much loss of chemical activity. The magnitude of the current pulse and the interval between pulses are chosen to minimize Joule heat while maximizing production of extra heat. This method takes advantage of the previously reported observation that heat is produced after applied current is turned off. However, for this effect to occur, a source of deuterium must exist behind the active surface. Therefore, the active surface can be applied to a layer of palladium of sufficient mass to supply deuterium during the time chosen for the applied current to be turned off. This mass of palladium is in the range of  $0.1 \text{ g/cm}^2$  and  $0.005 \text{ g/cm}^2$ .

Heating power is produced at both the anode and cathode, although the specially prepared cathode produces additional heating power. Therefore, if generated heat is to be used for some purpose or converted to electric power, a means must be used to transport this energy from both electrodes to where it is to be used. Such transport can be by physical contact with the conversion device or by using heat pipes if the conversion device is at some distance from the heat source. The method used to achieve energy conversion is not part of this patent because conventional methods are used.

The method can be adapted to generate heat for use in various applications, including maintaining the required temperature within a space craft, supplying environmental heat to maintain a comfortable temperature in cold environments, and supplying heat to accelerate certain chemical reactions including maintaining life of all forms. The heat can also be converted to electric energy by using suitable energy conversion devices.

FIG. 7 shows an exploded view of a device based on the principles taught in this patent.

The device includes the following components:

- 100 – Device or location at which the generated heat is used.
- 101 – Heat pipe used to conduct heat from its source to where it is used.
- 102 – Metal wall of heat producing device.
- 103 – Insulator used to keep the metal walls electrically isolated.
- 104 – Palladium layer applied to cathode metal wall.
- 105 – Energy producing layer applied to palladium layer.
- 106 – Liquid electrolyte that fills the space between the metal walls.
- 107 – Layer of platinum applied to anode metal wall.
- 108 – Tubing through which the electrolyte is pumped.

The device, when completely assembled, is designed to be gas and liquid tight, and be capable of withstanding an internal pressure of at least 5 atmospheres. Regulated DC current between  $1 \text{ A/cm}^2$  and  $10 \text{ A/cm}^2$  is supplied by the power supply shown. The current is applied with a pulse period between 0 cycles/sec (DC) and 100 cycles/sec. The heat pipes can be of any length and are used to carry heat to where it is required and/or to an energy conversion device where it can be converted to electric power. Part of this electric power can be applied to the cell by a suitable power supply as DC current or pulsed current, as described. The gap filled by the electrolyte between the anode and



cathode can be between 0.1 mm and 2 mm. The electrolyte concentration can be between 0.1N and 10 N, depending on the solubility of material dissolved in the H<sub>2</sub>O or D<sub>2</sub>O.

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While the present invention has been described in terms of specific embodiments, persons skilled in the art will recognize that many modifications and additions could be made to the specific embodiments without departing from the basic principals of the invention. For example, nano-particles on the surface of working electrodes may be comprised of a mixture of palladium, and/or gold, and/or adsorbed lithium and/or adsorbed calcium in intimate association with Deuterium. Other similar chemicals may also obvious choices to persons skilled in this art for producing excess heat when deposited on the surfaces of these electrodes. Therefore, the scope of the invention should be determined by the appended claims and their legal equivalents.